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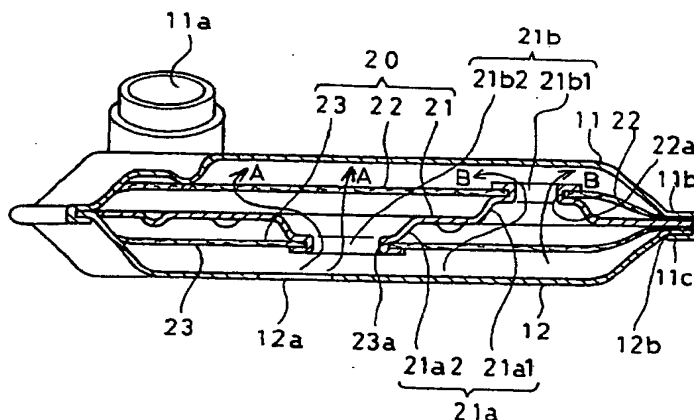
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## (54) Filter and filter medium unit for use therein

(57) A filter suitable for automobile oil filter includes a housing (10) with a pair of casings (11, 12) connected together with open ends facing each other and having respective communicating ports (11a, 12a), a partition wall (21) interposed between the open ends of the casings (11, 12) and having a peripheral edge held between the peripheral edges of the casings (11, 12) and first and second through holes (21b1, 21b2), and a filter medium unit (20) including a first filter medium (22) having a first communicating hole (22a) corresponding to the first through hole (21b1) of the partition wall (21) and a second filter medium (23) having a second communicating hole (23a) corresponding to the second through hole (21b2) of the partition wall (21). The first filter medium (22) is held between the peripheral edges of

the casings (11, 12) together with the peripheral edge of the partition wall (21) at one of two sides of the partition wall (21) so that the first through hole (21b1) and the first communicating hole (22a) are laid each one upon the other and so that a peripheral edge of the first filter medium (22) adheres closely to the side of the partition wall (21). The second filter medium (23) is held between the peripheral edges of the casings (11, 12) together with the peripheral edge of the partition wall (21) at the other side of the partition wall (21) so that the second through hole (21b2) and the second communicating hole (23a) are laid each one upon the other and so that a peripheral edge of the second filter medium (23) adheres closely to the side of the partition wall (21).

Fig.2



EP 0 787 519 A2

## Description

This invention relates to a filter suitable for use as oil filters for automobiles and a filter medium unit used therein.

FIGS. 6 and 7 illustrate a known filter of the above-described type. The filter comprises an upper casing 1 and a lower casing 2 each formed into the shape of a shallow dish and forming a housing 3. The upper and lower casings 1 and 2 are formed with an outlet port 1a and an inlet port 2a respectively. A filter medium 4 is configured to correspond with open ends of the casings 1 and 2. The open ends of the casings 1 and 2 are disposed to face each other with a filter medium 4 being interposed therebetween. The open edges of the casings 1 and 2 are flanged so that a peripheral edge of the filter medium 4 is held between the flanges. The peripheral edge of the upper casing 1 is crimped so as to enfold the peripheral edge of the lower casing 2. As a result, a continuous communicating path extending from the inlet port 2a across the filter medium 4 to the outlet port 1a is established in the housing 3.

The filter as constructed above is disposed in an oil pan, for example, and an oil pump is connected to the outlet port 1a so that fouled oil in the oil pan is drawn in through the inlet port 2. The drawn oil passes through the filter medium 4 to thereby be filtered, exiting through the outlet port 1a. In this construction, a filtration area which is one of factors determining a life period of the filter is only equal to a sectional area of the housing 3 when the filter medium 4 is usually flat. This poses a problem.

On the other hand, resin casings of the filters have recently been put to practical use. In the filters having the resin casings, the peripheral edge of the filter medium is held between the peripheral edges of the upper and lower casings by means of welding. FIG. 18 illustrates a prior art filter of this type. As shown, peripheral edges of two filter media 201 and 202 are placed between upper and lower casings 203 and 204. The upper and lower casings 203 and 204 are secured to each other by means of vibration welding with the filter media 201 and 202 being held therebetween.

In the vibration welding, the two filter media 201 and 202 are placed to directly face each other and rubbed together. Since the filter media 201 and 202 are formed of a fibrous material, fibers of the media are pressed against each other when the media are rubbed together, whereupon the vibration welding disadvantageously results in fuzz of the fibrous material.

Therefore, an object of the present invention is to provide a filter which can provide a larger filtration area.

To achieve the object, the present invention provides a filter comprising a housing including a pair of casings having respective open ends and connectable together with the open ends thereof facing each other, the casings having peripheral edges and communicating ports formed in portions thereof except for the open ends respectively so as to communicate with the exte-

rior so that a continuous communicating path is formed in the housing, a partition wall interposed between the open ends of the casings and having a peripheral edge held between the peripheral edges of the casings, the partition wall having first and second through holes, and a filter medium unit including a first filter medium having a first communicating hole corresponding to the first through hole of the partition wall and a second filter medium having a second communicating hole corresponding to the second through hole of the partition wall, the first filter medium being held between the peripheral edges of the casings together with the peripheral edge of the partition wall at one of two sides of the partition wall so that the first through hole and the first communicating hole are laid each one upon the other and so that a peripheral edge of the first filter medium adheres closely to the side of the partition wall, the second filter medium being held between the peripheral edges of the casings together with the peripheral edge of the partition wall at the other side of the partition wall so that the second through hole and the second communicating hole are laid each one upon the other and so that a peripheral edge of the second filter medium adheres closely to the side of the partition wall.

According to the above-described filter, the casings connectable together with the open ends facing each other are provided with the respective communicating ports each communicating with the exterior along with the respective open ends. The continuous communicating path is formed between the communicating ports in the housing. When a pump is connected to one of the communicating ports to be operated, oil or other fluid is caused to flow through the other communicating port and the communicating path to said one communicating path. The partition wall having the first and second through holes is interposed between the casings. The oil passes through either one of the through holes. The first filter medium covers one of two sides of the partition wall except for the first through hole, whereas the second filter medium covers the other side of the partition wall except for the second through hole. Accordingly, the oil passes through the second filter medium when flowing through the first through hole, and it passes through the first filter medium when flowing through the second through hole. Thus, the oil flowing through both communicating ports passes through either one of the first and second filter media disposed at the respective sides of the partition wall. Consequently, the filtration area is approximately twice as large as the sectional area of the housing except for the first and second through holes.

The present invention also provides a filter medium unit disposed across a communicating path, comprising a partition wall having first and second through holes, a first filter medium having a first communicating hole corresponding to the first through hole of the partition wall, the first filter medium having a peripheral edge adhering closely to a peripheral edge of the partition wall at one

of two sides of the partition wall so that the first through hole and the first communicating hole are laid each one upon the other, and a second filter medium having a second communicating hole corresponding to the second through hole of the partition wall, the second filter medium having a peripheral edge adhering closely to the peripheral edge of the partition wall at the other side of the partition wall so that the second through hole and the second communicating hole are laid each one upon the other.

According to the above-described filter medium unit, the oil is filtered by the second filter medium when flowing through the first through hole, whereas it is filtered by the first filter medium when flowing through the second through hole. Consequently, the filtration area is approximately twice as large as the sectional area of the partition wall disposed across the communicating path, except for the first and second through-holes.

The present invention further provides a filter including a pair of casings constituting a housing in which a filter medium unit is disposed across the interior thereof, the housing providing a communicating path. The filter comprises a partition wall interposed between the casings and having a pair of through holes, the filter medium unit including a first filter medium covering one of two sides of the partition wall except for one of the through holes and a second filter medium covering the other side of the partition wall except for the other through hole.

According to the above-described filter, the first and second filter media are also disposed at the respective sides of the partition wall across the communicating path in the housing. When passing through one of the through holes at one side of the partition wall, the oil is filtered by the filter medium at the other side of the partition wall. When passing through the other through hole, the oil is filtered by the filter medium at said one side of the partition wall. Consequently, the filtration area is approximately twice as large as the sectional area of the housing except for the first and second through holes.

According to the present invention, the oil or the like passes through either one of the two filter media disposed across the communicating path in the filter housing. Since an approximately double filtration area is obtained, the life period of the filter can be improved.

Another object of the present invention is to provide a filter in which the fuzz of the fibrous material can be restrained.

To achieve this object, the present invention provides a filter comprising a housing including a pair of casings having outlet and inlet ports respectively, the casings having respective open ends and connected together by means of a vibration welding so that the open ends thereof face each other, a plurality of filter media having respective edges held between the open ends of the casings so as to be disposed across a flow path for a fluid to be filtered extending between the outlet and inlet ports, and a plurality of holding plates dis-

posed between the edges of the filter media.

According to the above-described filter, a plurality of filter media are placed between the open ends of the casings in the assemblage of the filter. Furthermore, a plurality of holding plates are each held between each filter medium and the adjacent filter medium. The filter media are held between the casings and the holding plates when the casings are vibrated for the vibration welding. Consequently, since the filter media are prevented from being directly rubbed together, the fuzz of fibrous material for the filter media can be restrained. Furthermore, when a liquid to be filtered is caused to flow through the filter media between the inlet and outlet ports, dust is eliminated from the liquid. In this case, since the filter media are not rendered fuzzy, scattered fibers can be prevented from flowing out with the liquid.

A further another object of the present invention is to provide a filter in which displacement between the holding plates and the filter media can be prevented.

To achieve the object, the present invention provides a filter wherein each holding plate is formed with rugged faces at portions thereof facing the filter media.

According to the above-described filter, the rugged faces are formed on the portions of the surface of each holding plate facing the filter media. The rugged faces are pressed against the filter media to thereby bite into them when the filter media are held between the holding plates. Consequently, relative displacement between the holding plates and the filter media can be prevented. Furthermore, since chafing means need not be provided on the edge surfaces of the casings, the filter can be rendered simple in configuration.

A further another object of the present invention is to provide a filter wherein the filter media can be prevented from being subjected to an excessive force when the casings are vibrated for the vibration welding.

To achieve the object, the present invention provides a filter wherein each holding plate and a peripheral edge of each casing have opposite faces formed with respective meshing engagement portions for preventing falling-off of the filter medium in cooperation with each other.

According to the above-described filter, the holding plates and the peripheral edges of the casings hold the filter media in the meshing engagement therebetween. Consequently, relative displacement between the holding plates and the filter media can be prevented. Furthermore, since an amount of displacement of the casings is rendered smaller than an amount of displacement of the holding plate or plates and the casings, the filter media can be prevented from being subject to an excessive force.

The invention will be described, merely by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of a filter of a first embodiment in accordance with the present invention;

FIG. 2 is a partially broken side section of the filter;

FIG. 3 is an exploded perspective view of a filter medium unit used in the filter;

FIG. 4 is a partial sectional view of the filter medium, showing an assemblage step of the filter medium;

FIG. 5 is a partial sectional view of the filter medium, showing a completed state of the filter medium;

FIG. 6 is a side view of a conventional filter;

FIG. 7 is a sectional view of the conventional filter;

FIG. 8 is a perspective view of a filter of a second embodiment in accordance with the present invention;

FIG. 9 is a partially broken sectional view of the filter;

FIG. 10 is a sectional view of an edge portion of the filter;

FIG. 11 is an exploded perspective view of the filter medium unit used in the filter;

FIG. 12 is a sectional view of the filter medium, showing a welding step for a pedestal thereof;

FIG. 13 is a sectional view of the filter medium, showing a welded pedestal;

FIG. 14 is a perspective view of the filter of a modified form;

FIG. 15 is an exploded perspective view of the filter medium unit used in the modified form of filter;

FIG. 16 is a sectional view of an edge portion of the filter of another modified form;

FIG. 17 is a sectional view of an edge portion of the filter of further another modified form; and

FIG. 18 is a sectional view of an edge portion of a conventional filter.

A first embodiment of the present invention will be described with reference to FIGS. 1 to 5. Referring to FIG. 1, the filter of the first embodiment in accordance with the present invention is shown. A steel housing 10 of the filter comprises upper and lower casings 11 and 12 each formed into the shape of a shallow dish. The casings 11 and 12 are connected together so that the housing 10 has a hollow interior. The upper and lower casings 11 and 12 are formed with outlet and inlet ports 11a and 12a respectively. A continuous communicating path is provided between the inlet and outlet ports 12a and 11a in the housing 10. The lower casing 12 has a flange 12b which is formed on a peripheral edge thereof to extend outwardly in a coplanar relation with an open end face thereof. The upper casing 11 also has a flange 11b formed in the same manner as the flange 12b. The flange 11b has a short cylindrical crimped portion 11c extending from the distal end thereof toward the lower casing 12 facing the upper casing 11. The flange 12b of the lower casing 12 is inserted into the crimped portion 11c to be opposed to the flange 11b. Thereafter, the crimped portion 11c is crimped inwardly such that the upper and lower casings 11 and 12 are connected together with the open end faces facing each other.

The upper and lower casings 11 and 12 are connected together to constitute the generally thin box-shaped housing 10 in the embodiment. However, the housing 10 may be formed into any shape, provided that the communicating path is formed therein. For example, the housing 10 may be formed into the shape of an elongated cylinder. Furthermore, the housing 10 may be formed of a suitable resin, instead of steel. In case that the housing 10 is formed of a resin, the flange of the upper casing 11 cannot be crimped as described above. The flange may be secured to the flange 12a of the lower casing 12 by means of welding or by screws, instead. Furthermore, a filter medium unit 20 may constitute a part of the side wall of the housing 10.

The filter medium unit 20 is interposed between the upper and lower casings 11 and 12. The filter medium 20 comprises a steel partition wall 21 and first and second filter media 22 and 23 disposed at both sides of the partition wall 21. The partition wall 21 has two pedestals 21a1 and 21a2 which are formed to protrude from the upper and lower sides thereof. Each of the pedestals 21a1 and 21a2 has a flat top. The pedestals 21a1 and 21a2 have central through holes 21b1 and 21b2 respectively. Two short cylindrical members 21c1 and 21c2 each formed of a steel plate are secured to the peripheral edges of the holes 21b1 and 21b2 respectively. Each of the cylindrical members 21c1 and 21c2 has a bent lower end or flange so as to have an L-shaped cross section and a cylindrical portion. The flanges of the cylindrical members are welded to the peripheral edges of the through holes 21b1 and 21b2 respectively. The first and second filter media 22 and 23 have respective communicating holes 22a and 23a each located to correspond to either one of the cylindrical members 21c1 and 21c2. The cylindrical portion of the cylindrical member 21c1 is inserted through the communicating hole 22a of the first filter medium 22, whereas the cylindrical portion of the cylindrical member 21c2 is inserted through the communicating hole 23a of the second filter medium 23. Each cylindrical portion is crimped outwardly to be fixed to the filter medium, as shown in FIG. 5. As a result, the first and second filter media 22 and 23 are fixed in position such that the peripheral edges of the communicating holes 22a and 23a thereof adhere closely to the peripheral edges of the through holes 21b1 and 21b2 respectively. The communicating hole 22a of the first filter medium 22 serves as a first communicating hole, and the through hole 21b1 of the partition wall 21 serves as a first through hole. The communicating hole 23a of the second filter medium 23 serves as a second communicating hole, and the through hole 21b2 of the partition wall 21 serves as a second through hole.

The partition wall 21 has the same configuration as the first and second filter media 22 and 23. The peripheral edges of the partition wall 21 and the first and second filter media 22 and 23 are dimensioned so as to be held between the flanges 11b and 12b of the upper and lower casings 11 and 12. Accordingly, when the upper

and lower casings 11 and 12 are located to face each other with the filter medium unit 20 being interposed therebetween, the peripheral edges of the partition wall 21, first and second filter media 22 and 23 are held between the flanges 11b and 12b of the upper and lower casings 11 and 12, thereby adhering closely to the flanges 11b and 12b. The partition wall 21 is formed with a number of downwardly protruding small protrusions 21d over the entire surface thereof.

Although the filter medium unit 20 is arranged as described above in the embodiment, it may be modified in various manners. For example, when the housing 10 is cylindrical, the filter medium unit 20 may be pushed into the housing along the inner circumferential surface thereof, provided that the filter medium unit 20 is disposed across the interior of the housing. Furthermore, the upper and lower casings may hermetically be fixed to both sides of the filter medium 20 respectively.

Furthermore, three or more through holes may be formed in the partition wall 21 of the filter medium unit 20 although the partition wall 21 has two through holes 21b1 and 21b2 in the embodiment. In this case, the through holes need to be paired so that one of each pair is fixed to the peripheral edge of the first communicating hole of the first filter medium to adhere closely thereto, whereas the other of each pair is fixed to the peripheral edge of the second communicating hole of the second filter medium to adhere closely thereto.

The discrete short cylindrical member 21c is crimped for the fixing of the filter medium unit 20 in the embodiment. A cylindrical member may be formed directly on the distal end of the pedestal 21a and crimped to fix the filter medium unit, instead. Furthermore, the filter medium unit 20 may be bonded, or fixed by welding when the pedestal is formed of a resin. However, the first and second filter media 22 and 23 can be rendered thinner than the partition plate 21 when the discrete cylindrical member 21c is used for the fixing of the filter media as described above. As a result, the cylindrical member can easily be crimped and the degree of adhesion can be improved.

Each of the first and second filter media 22 and 23 is formed into a flat shape. The filter media may be embossed, corrugated or waved, instead. Each of the filter media 22 and 23 needs to adhere, on the peripheral edge thereof, closely to the partition wall 21. In the embodiment, the peripheral edges of the filter media are held between the upper and lower casings 11 and 12 together with the peripheral edge of the partition wall 21. The peripheral edges of the filter media may be bonded or welded to the partition wall 21, instead. In this case, the peripheral edge of the first filter medium 22 to be caused to adhere closely to the partition wall needs to encompass at least the second through hole 21b2, whereas that of the second filter medium 23 needs to encompass at least the first through hole 21b1 of the partition wall 21. Accordingly, the peripheral edge of each filter medium need not correspond with that of the partition wall 21. However, a larger filtration area can

be obtained when the peripheral edge of each filter medium corresponds with that of the partition wall 21. Furthermore, the filter medium unit 20 can be treated as a single unit when the first and second filter media 22 and 23 are individually fixed to the partition wall 21. Consequently, the assembly efficiency can be improved. Furthermore, the filter medium unit 20 disposed across the communicating path can be rendered replaceable when detachably inserted into the cylindrical housing from its side.

The protrusions 21d formed on the partition wall 21 are provided for preventing the side of either filter medium opposed to the inlet port from sticking to the partition wall 21. Although the shown protrusions are semispherical, the partition wall 21 may be ridged up or waved, instead, provided that a flow path is defined between the partition wall and either filter medium. Furthermore, spacers may be interposed between the partition wall 21 and either filter medium. Additionally, the semispherical small protrusions 21d protrude downwardly in the embodiment. The protrusions 21d thus need to be located at the same side as the inlet 12a of the housing 10. The protrusions are formed on the partition wall 21 to protrude upwardly when the inlet is formed in the upper face of the housing 10.

The operation of the filter will be described. The filter as constructed above is disposed in an oil pan in an automobile automatic transmission, for example. The outlet 11a formed in the upper casing 11 is connected to an oil pump (not shown). Upon start of an engine, the oil pump is driven so that fouled oil in the oil pan is drawn through the inlet 12a of the lower casing 12 into the housing 10 of the filter. The drawn oil passes through the filter medium unit 20 interposed between the upper and lower casings 11 and 12. There are two flow paths of the drawn oil. One of the flow paths is shown by arrows A in FIG. 2. The oil passes through the second through hole 21b2 of the partition wall 21 and thereafter passes through the first filter medium 22. The other flow path is shown by arrows B in FIG. 2. The oil first passes through the second filter medium 23 and then passes through the first through hole 21b1 of the partition wall 21. In each route, the oil passes through either one of the first and second filter media 22 and 23 while passing through the filter medium unit 20. These filter media are laid on both sides of the partition wall 21 respectively so as to constitute a single filter medium unit 20. Since the oil passes through either filter medium, the filtration area is approximately twice as large as the sectional area of the housing 10.

According to the above-described embodiment, the peripheral edges of the communicating holes 22a and 23a formed in the first and second filter media 22 and 23 are closely attached to the peripheral edges of the through holes 21b1 and 21b2 formed in the partition wall 21, respectively. The peripheral edges of both filter media 22 and 23 are held between the upper and lower casings 11 and 12 together with the peripheral edge of the partition wall 21 so as to be closely attached to the

peripheral edges of the casings. Having passed through the through hole 21b1 without passing through the first filter medium 22, the oil passes through the second filter medium 23. Having passed through the through hole 21b2 without passing through the second filter medium 23, the oil passes through the first filter medium 22. The oil thus passes through either one of the two filter media disposed across the communicating path in the housing 10. Consequently, since a double filtration area is obtained, the life period of the filter can be improved.

FIGS. 8 to 13 illustrate a second embodiment of the present invention. Referring to FIG. 8, the filter of the second embodiment is shown. A resin housing 110 of the filter comprises upper and lower casings 111 and 112 each formed into the shape of a shallow dish. The casings 111 and 112 are connected together so that the housing 110 has a hollow interior. The upper and lower casings 111 and 112 are formed with outlet and inlet ports 111a and 112a respectively. A continuous communicating path is provided between the inlet and outlet ports 112a and 111a in the housing 110. The lower casing 112 has a flange 112b which is formed on a peripheral edge thereof to extend outwardly in a coplanar relation with an open end face thereof. The upper casing 111 also has a flange 111b formed in the same manner as the flange 112b. The flanges 111b and 112b are hermetically secured together by a vibration welding as will be described later.

Although the two shallow dish shaped casings 111 and 112 form the hollow housing 110 in the embodiment, a cup-shaped casing and a lid may be used for the casings, instead, provided that a continuous flow path is defined in the housing. Furthermore, two cylindrical members may be connected together with open ends thereof facing each other. The number of each of the inlet 112a and outlet 111a may be increased. Each of the inlet and outlet ports 112a and 111a may be formed into the shape of a pipe. The outlet port 111a may have a flat outer end. Furthermore, the inlet port 112a and the outlet port 111a need not be formed in the lower and upper casings 112 and 111 respectively. The locations of the inlet and outlet ports may be changed depending upon a direction of filtration. Additionally, an amount of oil used can be reduced when the locations of the inlet and outlet ports correspond to the lowermost of the bottom of an oil tank in which the filter is accommodated.

The filter medium unit 120 is interposed between the upper and lower casings 111 and 112. The filter medium 120 comprises a resin holding plate 121 and first and second filter media 122 and 123 disposed at both sides of the holding plate 121, as shown in FIG. 11. The holding plate 121 has two pedestals 121a1 and 121a2 which are formed to protrude from the upper and lower sides thereof. The pedestals 121a1 and 121a2 have central through holes 121b1 and 121b2 and annular protruding walls 121c1 and 121c2 formed on the tops thereof circumferentially inwardly of the through holes 121b1 and 121b2, respectively, as shown in FIG.

12.

The first and second filter media 122 and 123 have respective communicating holes 122a and 123a located to correspond to the respective through holes 121b1 and 121b2. The wall 121c1 of the holding plate 121 is inserted into the communicating hole 122a of the first filter medium 122, whereas the wall 121c2 of the holding plate 121 is inserted into the communicating hole 123a of the second filter medium 122. The walls 121c1 and 121c2 extend out of the communicating holes 122a and 123a respectively when the first and second filter media 122 and 123 are placed on the pedestals 121a1 and 121a2 respectively. Two annular welding plates 124 are fixed to the walls 121c1 and 121c2 by the vibration welding, respectively, so that the first and second filter media 122 and 123 are closely fixed to the holding plate 121.

Each of the welding plates 124 is formed into an annular shape having an outer edge with a diameter larger than that of each of the walls 121c1 and 121c2 and an inner edge with a diameter smaller than that of each of the through holes 121b1 and 121b2. The welding plates 124 have low walls 124a located to be opposed to the walls 121c1 and 121c2 and high walls 124b protruding toward the pedestals 124b from the inner edges, respectively. Each high wall 124b is formed so as not to reach the surface of the pedestal 121a when the walls 121c and 124a are opposed to each other.

Frictional heat melts down the walls 121c1 and 121c2 when the welding plates 124 are vibrated, pushed against the respective pedestals 121a1 and 121a2. The deposition plates 124 come closer to the pedestals 121a1 and 121a2 such that the first and second filter media 122 and 123 are pressed to thereby be fixed to the respective pedestals 121a1 and 121a2. The high walls 124b of the welding plates 124 are abutted against the respective pedestals 121a1 and 121a2 upon completion of the vibration welding.

The holding plate 121 has the same configuration as the first and second filter media 122 and 123. The peripheral edges of the holding plate 121 and the filter media 122 and 123 are dimensioned so as to be held between the flanges 111b and 112b of the upper and lower casings 111 and 112. Accordingly, when the upper and lower casings 111 and 112 are located to face each other with the filter medium unit 120 being interposed therebetween, the peripheral edges of the holding plate 121, first and second filter media 122 and 123 are held between the flanges 111b and 112b of the upper and lower casings 111 and 112. Since the holding plate 121 is held between the first and second filter media 122 and 123, these filter media are not in direct contact with each other. The holding plate 121 is formed with a number of downwardly protruding small protrusions 121d over the entire surface thereof.

The flanges 111b and 112b of the upper and lower casings 111 and 112 each have a slightly larger diameter than the peripheral edge of the filter medium unit 120, so that the casings are fixed together at the flanges

111b and 112b by the vibration welding as in the opposite faces of the welding plates 124 and the pedestals 121a. More specifically, the flange 111b of the upper casing 111 has a wall 111b1 formed on the radially mid-way portion thereof and another wall 111b2 formed inwardly of the wall 111b1, as shown in FIG. 10. The flange 112b of the lower casing 112 has a wall 112b2 located to be opposed to the wall 111b2 of the upper casing 111. The flange 112b further has another wall 112b3 formed on its outermost edge. When the flanges 111b and 112b are located to be opposed to each other, the wall 111b1 of the upper casing 111 abuts against the flange 112b of the lower casing 112 such that a space is defined between the inner walls 111b2 and 112b2 and such that the outward wall 112b is not abutted against the flange 111b. When pressure and vibration are applied to the flanges 111b and 112b, the midway wall 111b1 and the flange 112b are rubbed against each other to thereby generate frictional heat, which heat gradually melts the wall 111b1 and the flange 112b such that both are fixed together.

In the above-described vibration deposition, a portion of the first filter medium 122 inside the wall 111b2 is pushed at its upper side against the flange 111b, whereas a portion of the second filter medium 123 inside the wall 112b2 is pushed at its lower side against the flange 112b. Accordingly, the vibration is applied to the filter media 122 and 123 while they are held between the holding plate 121 and the flanges of the casings, so that the filter media are gradually pushed against the flanges of the casings.

On the other hand, the first and second filter media are in direct contact with each other in the prior art. Accordingly, applied vibration acts so that the filter media are pushed and rubbed against each other, resulting in fibrous fuzz of both filter media. The fuzz results in scattering of fibers. Furthermore, the strength in the peripheral edge of each filter medium held between the flanges 111b and 112b is lowered. As a result, the life period of the prior art filter needs to be set to be shorter than the original one determined according to the strength in the other portions of the filter.

In the embodiment, however, the holding plate 121 is interposed between the first and second filter media 122 and 123. Accordingly, since the filter media are not in direct contact with each other, the fuzz can be prevented. Furthermore, an amount of movement of each filter medium due to vibration of each of upper and lower sides is one half, whereupon the fuzz can also be prevented and damage to the fibers can be reduced.

The holding plate 121 extends across the interior of the housing 110 in the embodiment. The holding plate needs to be interposed at least between the peripheral edges of the filter media 122 and 123. FIGS. 14 and 15 illustrate a modified form of the holding plate. As shown, the holding plate 125 is formed into the shape of a frame and held between the peripheral edges of the first and second filter media 126 and 127. The second filter medium 127 has a through hole 127a formed to corre-

spond to the inlet 112a of the lower casing 112. The second filter medium 127 is fixed at the periphery of the through hole 127a to the periphery of the inlet 112a of the lower casing 112 by the deposition plate 128. The first and second filter media 126 and 127 have through holes 126a and 127b formed to be opposed to each other, respectively. Peripheral edges of the through holes 126a and 127b are bonded together. In this construction, too, when the upper and lower casings 111 and 112 are located to face each other with the filter medium unit 120 being interposed therebetween, the peripheral edges of the holding plate 125, first and second filter media 126 and 127 are held between the flanges 111b and 112b of the upper and lower casings 111 and 112. Accordingly, since the filter media 126 and 127 are not in direct contact with each other, the fuzz can be prevented when the vibration welding is carried out.

Furthermore, the holding plate 121 has two annular ribs 121e1 and 121e2 formed on both sides of the peripheral edge thereof respectively, as shown in FIG. 10. The ribs 121e1 and 121e2 bite into the first and second filter media 122 and 123 respectively when the peripheral edges of the filter media are held between the flanges 111b and 112b. As a result, the filter media can securely be fixed.

The ribs 121e1 and 121e2 are formed only on the holding plate 121 in the embodiment. As shown in FIG. 16, the flanges 111b and 112b of the casings 111 and 112 are also formed with ribs 111b4 and 112b4 as well as the ribs formed on the holding plate 121. In this case, the filter media can further be prevented from falling off. Furthermore, when concavities are formed in the flanges 111b and 112b and/or the holding plate 121, corners of the concavities bite into the filter media. A number of small protrusions may be formed, instead of the ribs. When the flanges 111b and 112b and the peripheral edge of the holding plate 121 are rugged, meshing engagement prevents the filter media from falling off in a most effective manner.

A single holding plate 121 need not be interposed between the two filter media, provided that the filter media are not in direct contact. In further another modified form as shown in FIG. 17, three filter media 129 are used and two holding plates are interposed between the filter media.

The operation of the filter of the second embodiment will be described. The filter as constructed above is disposed in an oil pan in an automobile automatic transmission, for example. The outlet 111a formed in the upper casing 111 is connected to an oil pump (not shown). Upon start of an engine, the oil pump is driven so that fouled oil in the oil pan is drawn through the inlet 112a of the lower casing 112 into the housing 110 of the filter. The drawn oil passes through the filter medium 120 interposed between the upper and lower casings 111 and 112. There are two flow paths of the drawn oil. One of the flow paths is shown by arrows A in FIG. 9. The oil passes through the second through hole 121b2



of the holding plate 121 and thereafter passes through the first filter medium 122. The other flow path is shown by arrows B in FIG. 9. The oil first passes through the second filter medium 123 and then passes through the first through hole 121b1 of the holding plate 121. In each route, the oil passes through either one of the first and second filter media 122 and 123 while passing through the filter medium unit 120. These filter media are laid on both sides of the holding plate 121 respectively so as to constitute a single filter medium 120. Since the oil passes through either filter medium, the filtration area is approximately twice as large as the sectional area of the housing 110.

The second filter medium 123 is pushed against the holding plate 121 when the oil flows through the paths shown by arrows B in FIG. 9. The small protrusions 121d can prevent the second filter medium 123 from stacking on the holding plate 121.

In the construction shown in FIG. 14, the oil drawn in through the inlet 112a flows into a space between the first and second filter media 122 and 123. Then, the oil, having passed through the upper first filter medium 122, flows to the outlet 111a. The oil, having passed through the lower second filter medium 123, flows upwardly through the through holes 126a and 127b to the outlet 111a.

According to the second embodiment, the rectangular, shallow dish shaped upper and lower casings 111 and 112 having the outlet 111a and the inlet 112a respectively are placed to be opposed to each other with the open ends facing each other. The peripheral edges of the filter media 122 and 123 are held between the flanges 111b and 112b of the casings 111 and 112 for the vibration welding. Since the holding plate 121 is interposed between the filter media 122 and 123, the filter media are not in direct contact with each other even when the flanges are subjected to vibration. Furthermore, the fuzz can be prevented and damage to the fibers can be reduced.

## Claims

1. A filter including a housing (10) including a pair of casings (11, 12) having respective open ends and connectable together with the open ends thereof facing each other, the casings (11, 12) having peripheral edges and communicating ports (11a, 12a) formed in portions thereof except for the open ends respectively so as to communicate with the exterior so that a continuous communicating path is formed in the housing (10), characterized by a partition wall (21) interposed between the open ends of the casings (11, 12) and having a peripheral edge held between the peripheral edges of the casings (11, 12), the partition wall (21) having first and second through holes (21b1, 21b2), and a filter medium unit (20) including a first filter medium (22) having a first communicating hole (22a) corresponding to the first through hole (21b1) of the par-

ition wall (21) and a second filter medium (23) having a second communicating hole (23a) corresponding to the second through hole (21b2) of the partition wall (21), the first filter medium (22) being held between the peripheral edges of the casings (11, 12) together with the peripheral edge of the partition wall (21) at one of two sides of the partition wall (21) so that the first through hole (21b1) and the first communicating hole (22a) are laid each one upon the other and so that a peripheral edge of the first filter medium (22) adheres closely to the side of the partition wall (21), the second filter medium (23) being held between the peripheral edges of the casings (11, 12) together with the peripheral edge of the partition wall (21) at the other side of the partition wall (21) so that the second through hole (21b2) and the second communicating hole (23a) are laid each one upon the other and so that a peripheral edge of the second filter medium (23) adheres closely to the side of the partition wall (21).

2. A filter medium unit disposed across a communicating path, characterized by a partition wall (21) having first and second through holes (21b1, 21b2), a first filter medium (22) having a first communicating hole (22a) corresponding to the first through hole (21b1) of the partition wall (21), the first filter medium (22) having a peripheral edge adhering closely to a peripheral edge of the partition wall (21) at one of two sides of the partition wall (21) so that the first through hole (21b1) and the first communicating hole (22a) are laid each one upon the other, and a second filter medium (23) having a second communicating hole (23a) corresponding to the second through hole (21b2) of the partition wall (21), the second filter medium (23) having a peripheral edge adhering closely to the peripheral edge of the partition wall (21) at the other side of the partition wall (21) so that the second through hole (21b2) and the second communicating hole (23a) are laid each one upon the other.

3. A filter including a pair of casings (11, 12) constituting a housing (10) in which a filter medium unit (20) is disposed across the interior thereof, the housing (10) providing a communicating path, characterized by a partition wall (21) interposed between the casings (11, 12) and having a pair of through holes (21b1, 21b2), and in that the filter medium unit (20) includes a first filter medium (22) covering one of two sides of the partition wall (21) except for one (21b1) of the through holes (21b1, 21b2) and a second filter medium (23) covering the other side of the partition wall (21) except for the other through hole (21b2).

4. A filter including a housing (110) including a pair of casings (111, 112) having outlet and inlet ports



(111a, 112a) respectively, the casings (111, 112) having respective open ends and connected together by means of a vibration welding so that the open ends thereof face each other, and a plurality of filter media (122, 123) having respective edges held between the open ends of the casings (111, 112) so as to be disposed across a flow path extending between the outlet and inlet ports (111a, 112a), characterized by a plurality of holding plates (121) disposed between the edges of the filter media (122, 123).

5. A filter according to claim 4, characterized in that each holding plate (121) is formed with rugged portions (121e1, 121e2)) at portions thereof facing the filter media (122, 123) respectively.
6. A filter according to claim 4 or 5, characterized in that each holding plate (121) and a peripheral edge of each casing (111, 112) have opposite faces formed with respective meshing engagement portions (121e1, 121e2, 111b4, 112b4) for preventing falling-off of each filter medium (122, 123) in cooperation with each other.

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Fig.1

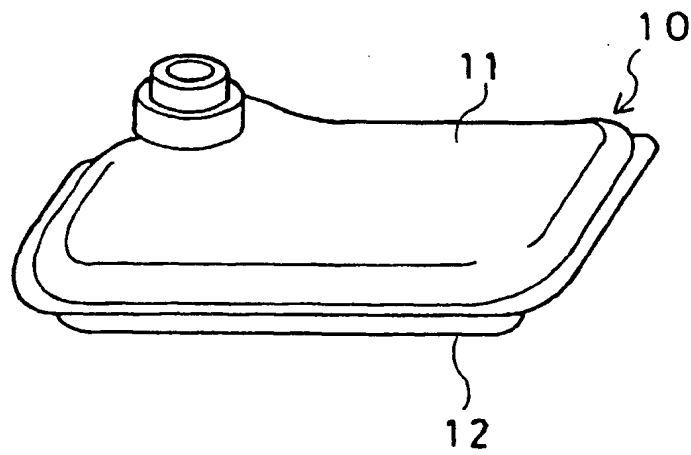


Fig.2

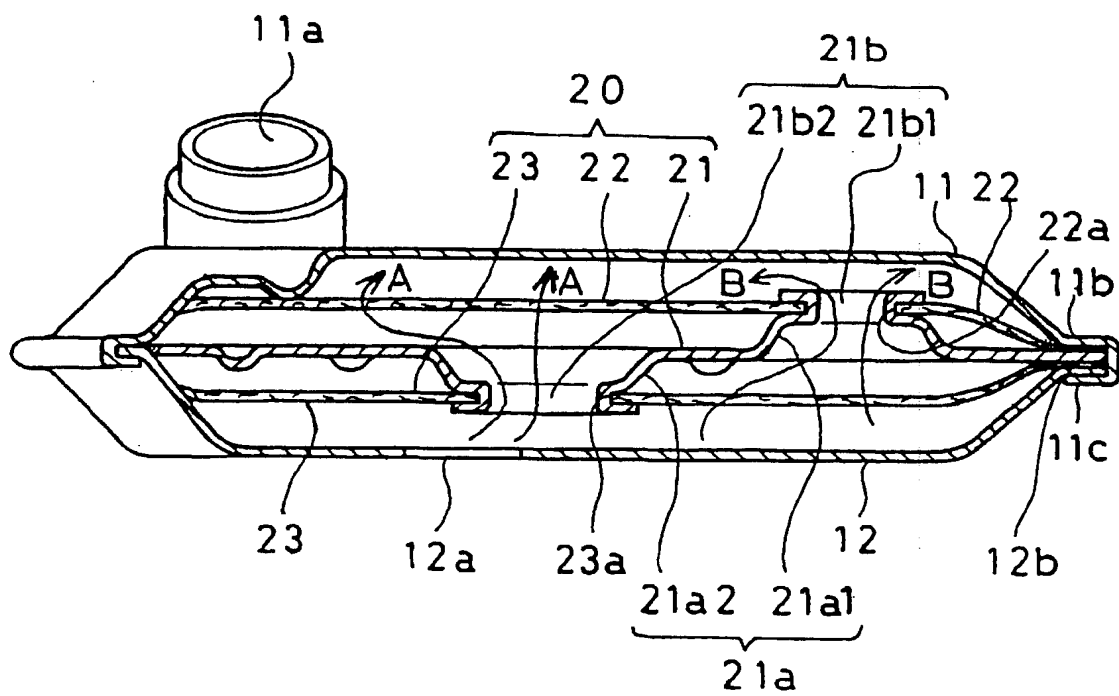


Fig.3

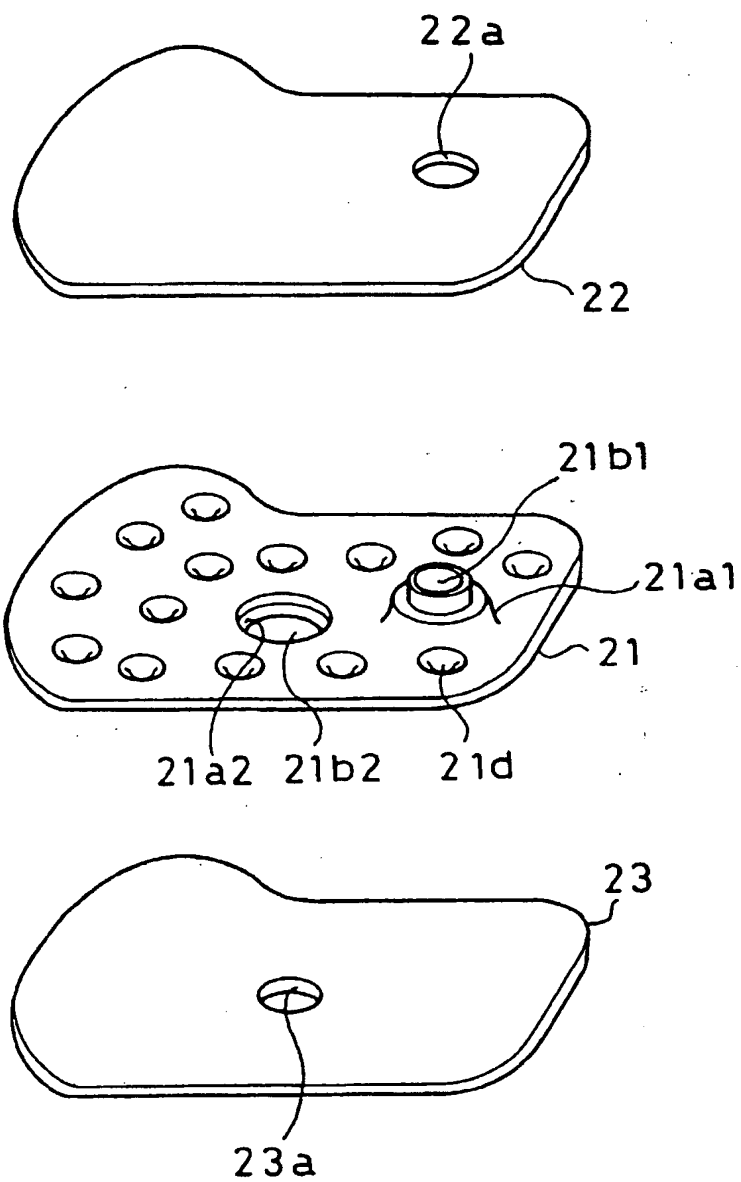


Fig.4

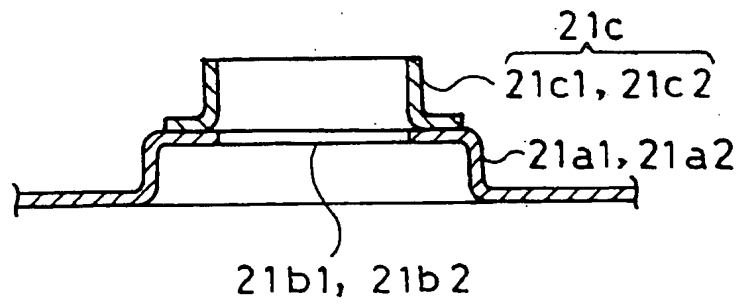


Fig.5

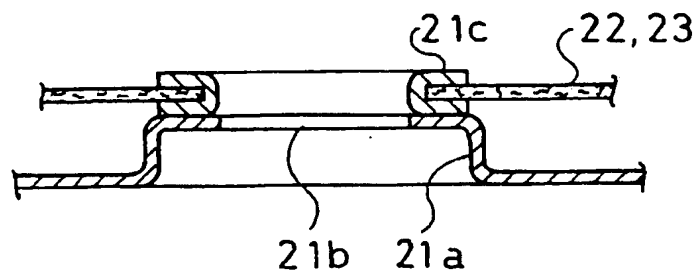
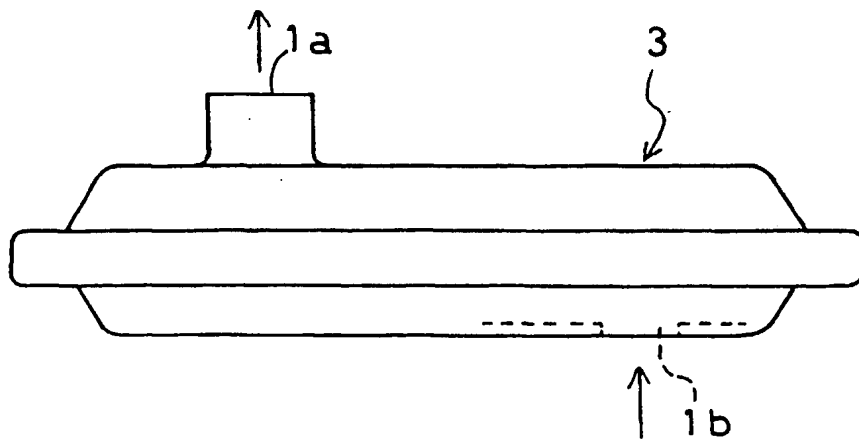


Fig.6



Prior Art

Fig.7

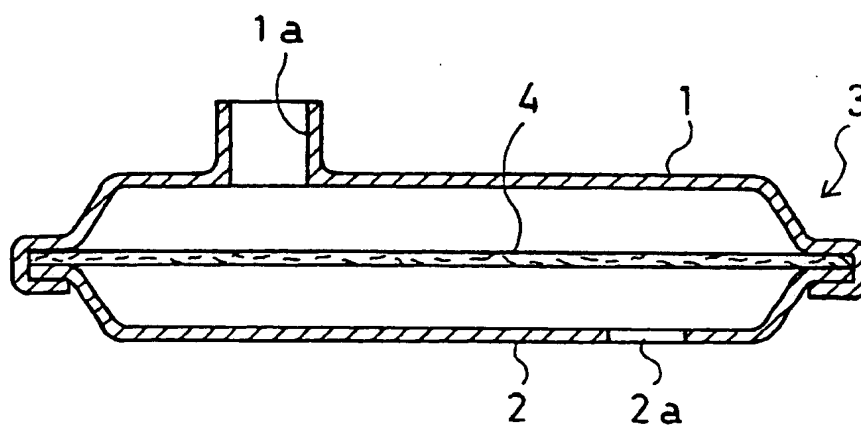




Fig.8

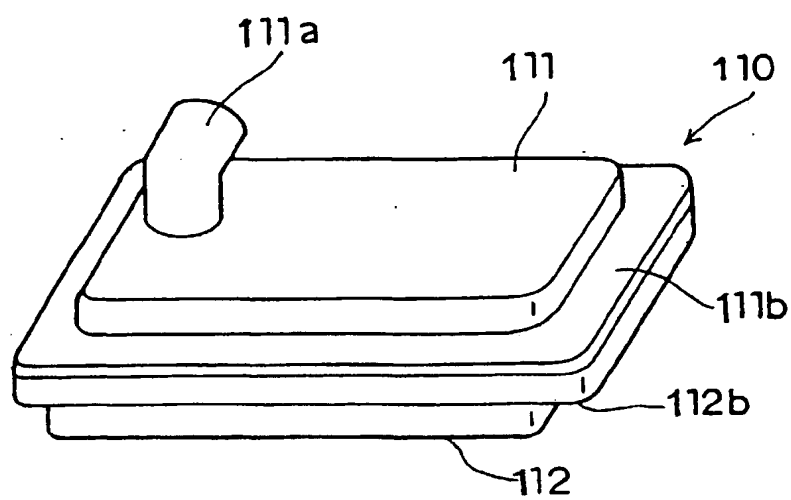


Fig.9

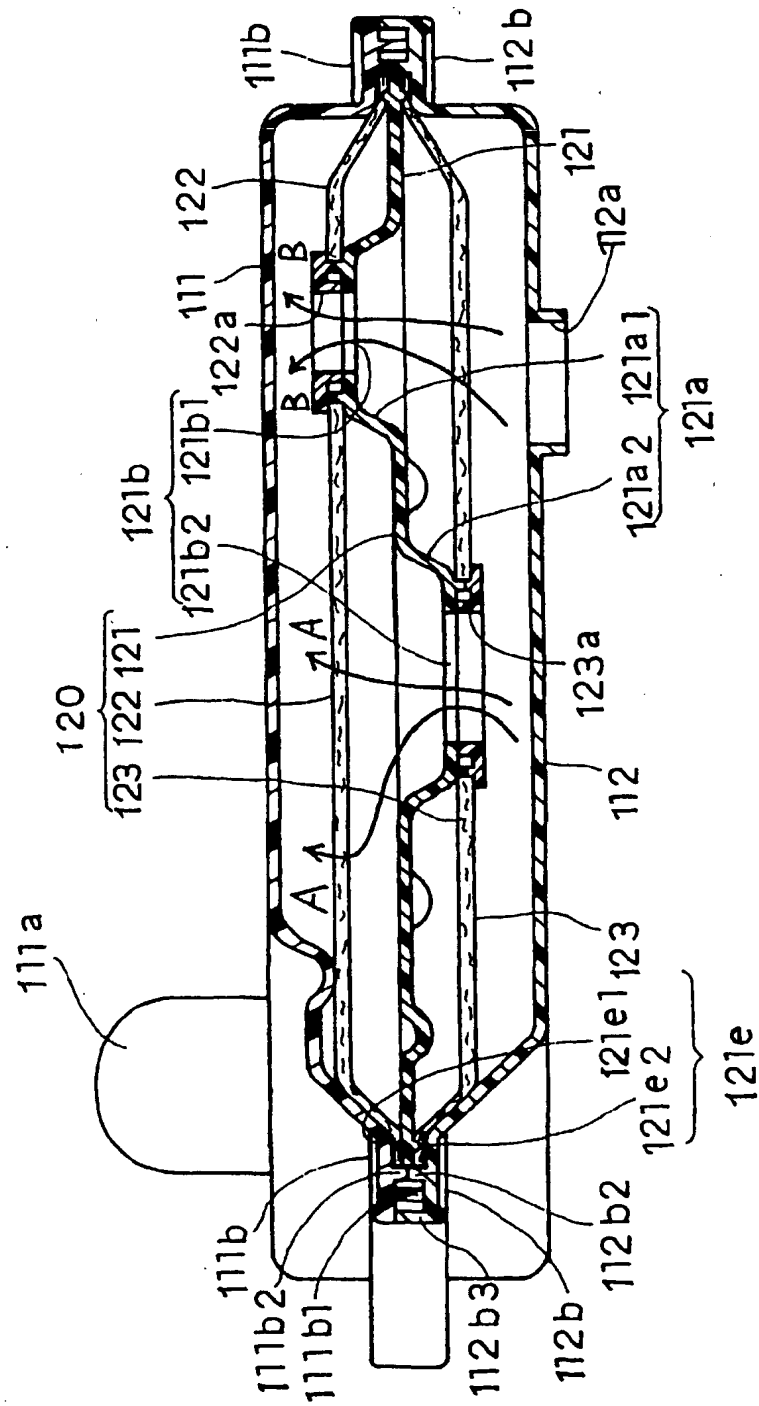


Fig.10

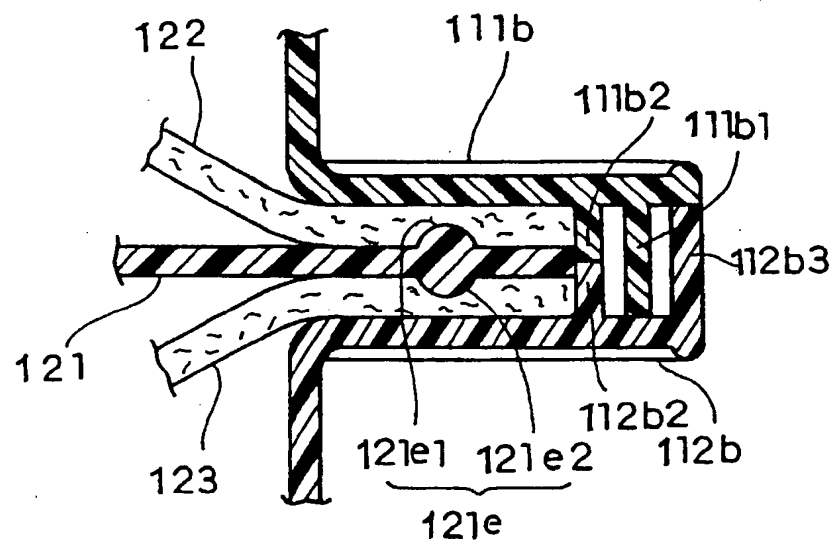


Fig. 11

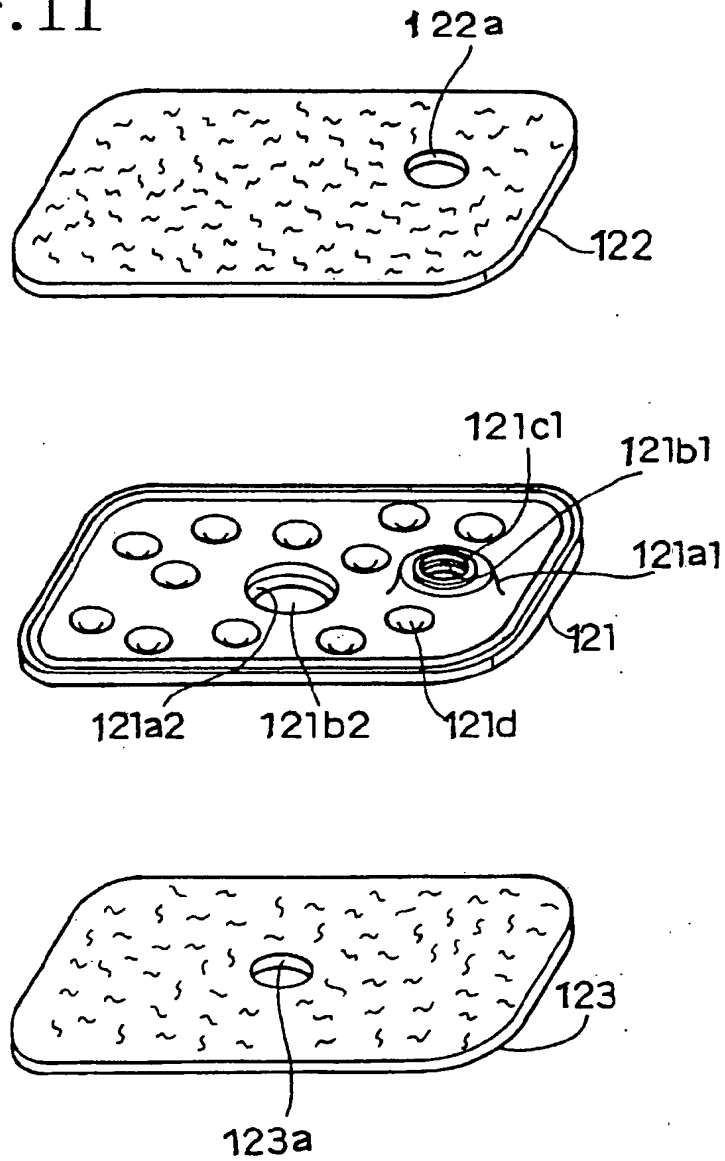


Fig.12

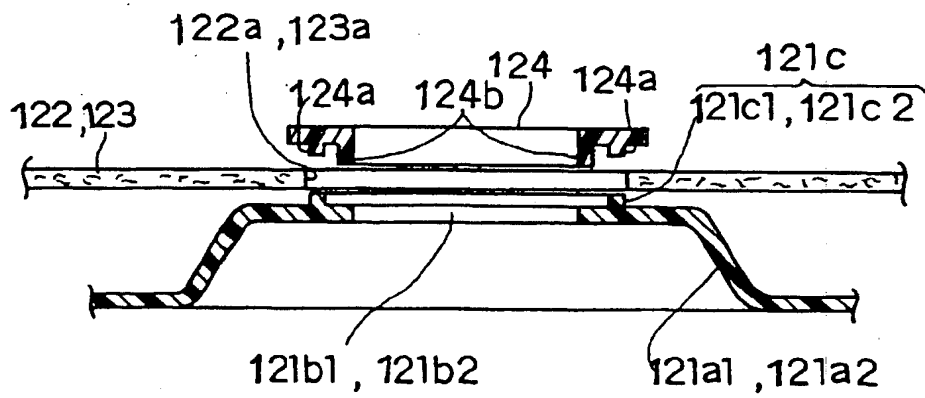


Fig.13

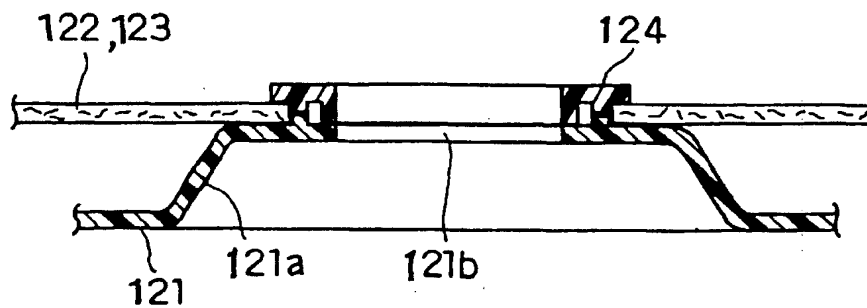


Fig.14

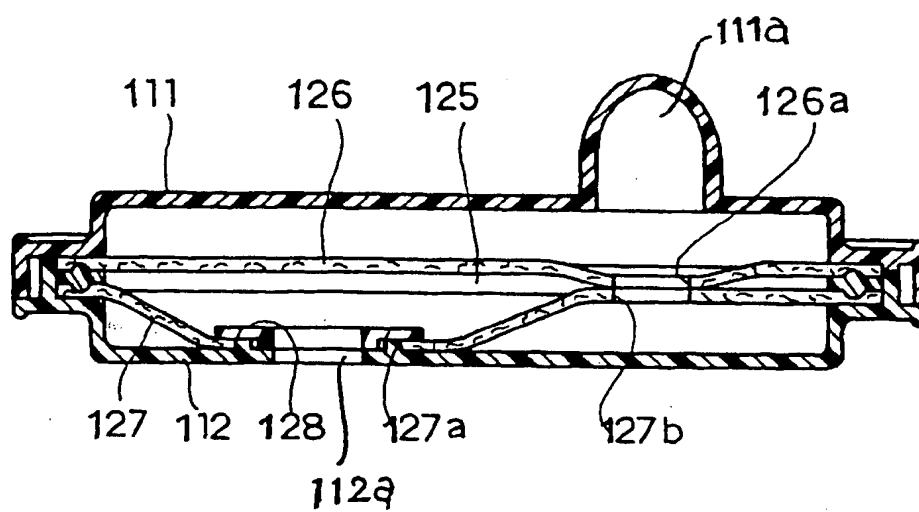


Fig.15

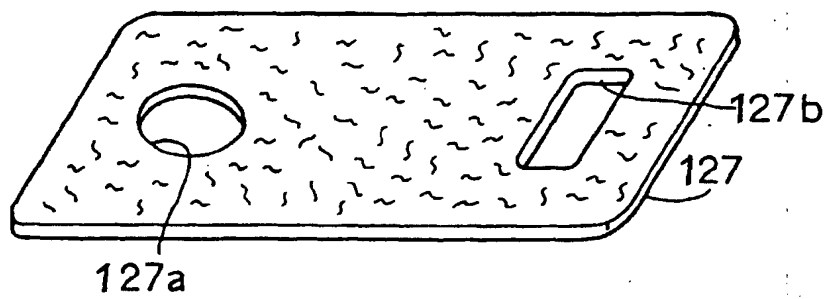
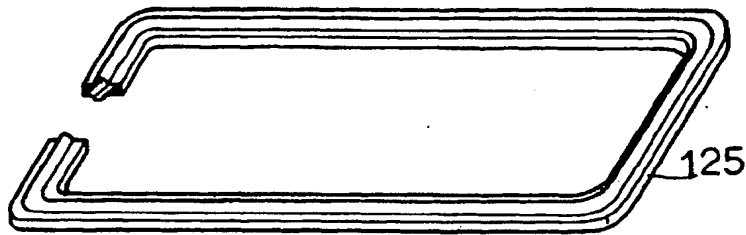
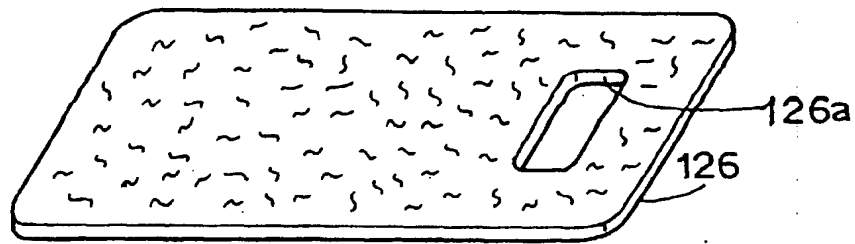




Fig.16

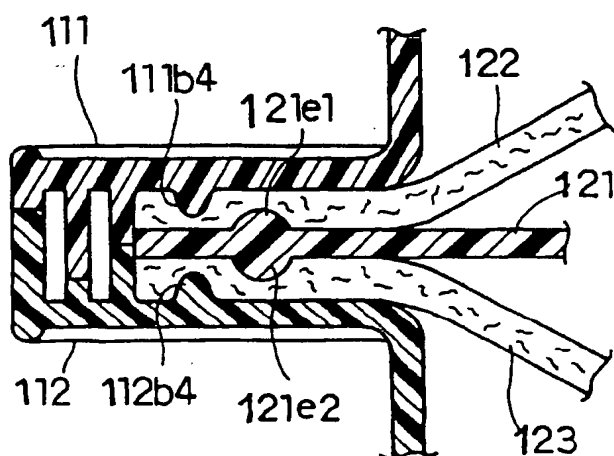


Fig.17

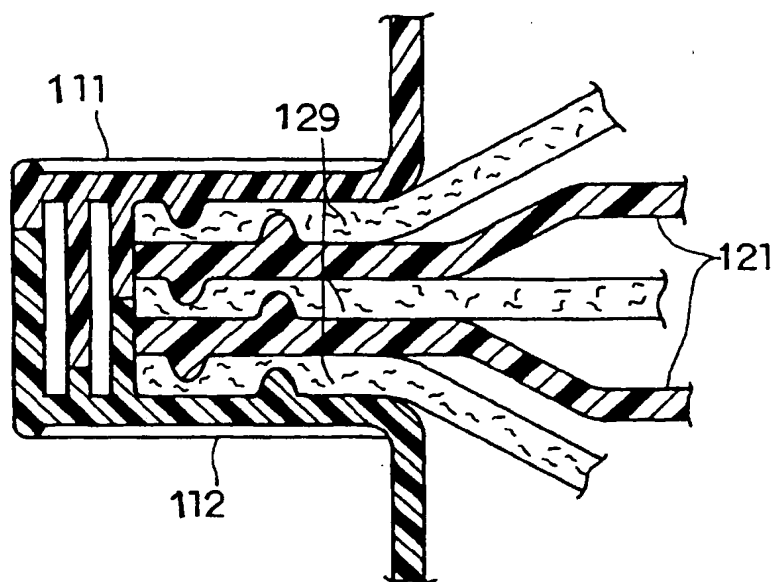
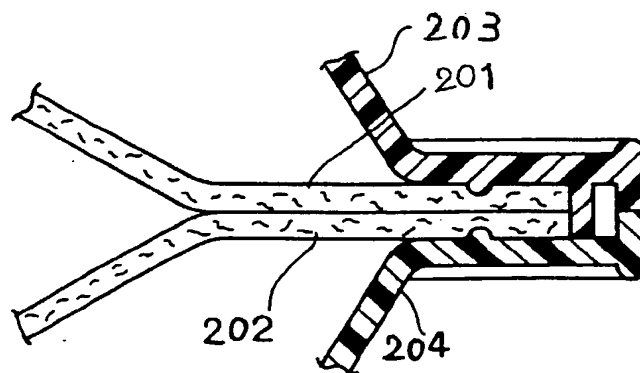


Fig.18



Prior Art